



MICHIGAN DEPARTMENT OF NATURAL RESOURCES
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THE 2003 DEER PELLET GROUP SURVEYS

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INTRODUCTION

The Michigan Department of Natural Resources (DNR) has the authority and responsibility to protect and manage the wildlife resources of the State of Michigan. To carry out these responsibilities, the DNR must collect data on several different aspects of Michigan's wildlife populations. Field surveys are techniques used to collect sample data to estimate population size and other population parameters of a wildlife species, based on statistical principles. Since wildlife populations can be elusive and difficult to capture or observe, field surveys often draw inferences about a wildlife population based on observations of signs a species leaves. The pellet group survey is one such survey and is designed to estimate deer density from the amount of fecal debris (pellet groups) deposited over a known period of time within a fixed area. Experienced hunters frequently use pellet group sightings as a measure of the abundance of deer in an area. The pellet group survey is a formal extension of this common technique.

RATIONALE

Bennett et al (1940) first described the use of pellet counts as an index of deer abundance. They correlated the number of pellet groups per acre to the best known estimate of the deer population to determine the relationship between pellet group deposition and deer density within particular habitats and seasons. McCain (1948) was the first to describe the conversion of pellet group counts to an estimate of population density. Michigan has used the pellet group survey method since 1953 and the methods are reviewed in detail in Ryel (1971). The current methods require that we know: (1) the length of time over which the pellet groups are deposited (called the deposition period); (2) the deer mortality over the deposition period; (3) the number of pellet groups deposited; and (4) the deposition rate (the number of pellet groups deposited per deer day). Dividing the number of pellet groups on an area by the deposition rate provides an estimate of the number of deer-days of use. If we know the number of days in the deposition period, we can then estimate the number of deer present. Mortality during the deposition period affects the deposition, but we can correct for these effects using the mortality data.



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The number of pellet groups deposited is estimated through the pellet group searches, described below. The deposition rate was determined through studies of penned deer and is estimated as 13.47 pellet groups deposited per deer day in the Upper Peninsula (UP) and 13.37 pellet groups deposited per deer day in the Northern Lower Peninsula (NLP).

The deposition period is defined as the number of days between the date of leaf fall in the autumn and the average sampling date in the spring. Each autumn the local wildlife staff note when the majority of the leaves have fallen in their unit. Pellet groups deposited before leaf fall are covered by the leaves and are not visible during the spring. Thus, only those groups deposited during the defined deposition period are counted during the survey. In sparsely wooded areas, staff differentiate between old and new pellet groups based on their physical condition.

Mortality over the deposition period can occur through both harvest and non-harvest events. Harvest mortality is estimated in the annual deer harvest mail survey (Frawley 2003). Non-harvest mortality is estimated through the dead deer searches. These searches are run concurrently with the pellet group surveys; at each pellet group survey location, the staff also count the number of dead deer. During years when especially high winter losses are expected, the staff may also conduct additional dead deer searches independent of the pellet group searches.

SAMPLING METHODS

Annual pellet group surveys cover individual units of the UP and the NLP. Combined, the units may cover the entire UP or NLP, or they may cover only a portion of these areas based on available personnel resources and current data needs. The survey generates a population estimate for each individual unit. Agricultural fields and urban developments cover the majority of the Southern Lower Peninsula (SLP). Without large tracks of forested land to provide leaf litter to cover old pellet groups, the SLP is not suited to the pellet group survey methods.

Since it would be impossible to search every square mile of the survey units for deer pellet groups, the survey makes use of a 2-stage sampling scheme to select individual courses on which observations are made. The sample results are then extrapolated to the full extent of the represented unit.

The first sampling stage follows a stratified sampling design to select the sections (1 mi² units) to include in the survey. Approximately every 5 years, wildlife staff working in the northern deer range classify each section in their area as belonging to a stratum of high (Stratum I), medium (Stratum II), or low (Stratum III) deer winter population density. Sections with water covering over half their area are not stratified and are not available for sampling in the pellet group survey. An optimal allocation technique divides a unit's samples among the strata. Sections are then randomly chosen for sampling, one section for each sample required. Within each stratum, each section has the same probability of being selected for sampling. This stratified random sampling technique focuses sampling effort on those areas where it will be most valuable and provides more precise estimates than a simple random sampling technique.

The second stage of the 2-stage sampling scheme randomly selects the location of the course's starting point within each chosen section. A course contains 5 $\frac{1}{50}$ acre rectangular plots, located along a transect, in which the staff count the number of new pellet groups (deposited since leaf fall). The 5 plots are located at regular intervals along the transect, beginning a random distance from the starting point of the course. The same courses are run each year until the state is restratified.

Once a course and plots have been established, a 2-person crew, at least one of whom is usually an experienced surveyor, searches each plot for pellet groups. Each person counts the pellets on half of each plot, placing a disk on each group. The counters then switch halves, each looking for pellet groups the other may have missed.

SOURCES AND CONTROL OF ERROR

Errors in counting and aging the pellet groups, estimating the deposition rate and length of deposition period, and sampling error (due to random variation in the number of pellet groups per course) can affect the final estimate of deer population density. A recent evaluation of the pellet group survey found that over the range of possible values for the number of deposition days, the actual number pellet groups per course, and the deposition rate, the accuracy of the estimates of deer population density is probably most dependent on having an accurate estimate of the deer deposition rate (Cook and Winterstein, unpublished report).

The system of concurrent rechecks and the counting of only those pellet groups deposited on top of the leaf litter reduces the error associated with counting and aging the pellet groups. Noting the date when the majority of leaves have fallen and conducting the sampling over as short a time frame as possible reduces the error associated with estimating the number of deposition days.

Several different studies have reported deer defecation rates. The defecation rates (13.37 in the NLP and 13.47 in the UP) used in the pellet group survey calculations are based on studies conducted in Michigan and closely agree with the rates (between 11.5 and 14.6) published in McCain (1948) and Eberhardt and Van Etten (1956). Rogers (1987) reported much higher deposition rates (>22.3) of deer in northeastern Minnesota. Although the deposition rates used in the survey calculations may not be exact, any bias in the resulting population estimates should be consistent from year to year, making annual comparisons valid.

Due to the difficulties in accounting for all sources of error, the pellet group survey results are an index of population density rather than a direct estimate of population size. An index is a relative measure of a population parameter and has meaning only in comparison to other values of the same index. As an index, the pellet group survey results are useful in tracking annual changes (increases or decreases) in deer density and in comparing the relative deer densities of different units. The primary result of the pellet group survey, the average number of pellet groups per course, could be used as the index to make these temporal or spatial comparisons. To ease interpretation, however, the groups/course are extrapolated to the scale of deer population

size and density through the computations described below. The extrapolated values are presented as estimates, but must not be interpreted as exact measures of the deer population. Estimates of population size and density and the suggested change of abundance over time should be considered in relation to other sources of information used to track or estimate population abundance.

COMPUTATIONS

The pellet group survey first estimates the mean (\bar{x}_j) and standard deviation (s_j) of the number of deer pellet groups found per course within each stratum and averaged over each surveyed unit (\bar{x}_{st}) . The average number of groups per course over each unit is calculated following the procedures in Cochran (1953) for stratified random sampling:

$$\bar{x}_{st} = w_1\bar{x}_1 + w_2\bar{x}_2 + \dots + w_n\bar{x}_n$$

where w_j is the proportion of the total number of sections in Stratum 1 through n (here $n = 3$).

The stratum variance $v(\bar{x}_{st})$ is calculated as:

$$v(\bar{x}_{st}) = w_1^2 v(\bar{x}_1) + w_2^2 v(\bar{x}_2) + \dots + w_n^2 v(\bar{x}_n)$$

where $v(\bar{x}_j)$ is the variance of the stratum average, calculated as:

$$v(\bar{x}_j) = \frac{s_j^2}{n}$$

From the unit's average number of groups per course, we can estimate the unadjusted average number of deer per section (N_{unadj}) within the unit:

$$N_{unadj} = \frac{(\bar{x}_{st} * 50 * 640)}{(D * R * 5)}$$

where D is the number of days in the deposition period and R is the deposition rate. The constant $\frac{50 * 640}{5}$ converts the counts from “per course” to “per section.” (Dividing the average groups

per course by 5 gives the average groups per plot because a course consists of 5 plots. The resulting value is multiplied by 50 to calculate average groups per acre, because the plots are $\frac{1}{50}$ acre, and then multiplied by 640 acres per section to estimate the number of groups per section.) Multiplying the number of deer per section by the number of sections in the unit provides an estimate of the unadjusted over-winter population. These estimates are called unadjusted (or uncorrected) because they do not account for deer that died during the deposition period. The population estimate is, therefore, considered the average over-winter deer population. Table 1 shows the stratum estimates and Table 2 shows unit estimates.

Deer that die during the deposition period contribute to the total number of pellet groups, but do not contribute for the same number of days as deer that survive the entire deposition period. For example, a deer killed during the regular firearm season was alive for approximately 1 month of the deposition period. Four deer killed during firearm season (alive for 1 month of the deposition period) would contribute the same number of pellet groups as 1 deer alive for 4 months of the deposition period. We make use of this relationship to adjust for over-winter

removals. The deer harvest mail survey and the dead deer survey provide estimates of the number of deer dying throughout the deposition period and how many days they may have been present. To derive a spring population estimate, we adjust for the number of deer removed and the length of time they were present during the deposition period. To derive a fall population estimate, we add all over-winter removals (not adjusted for the time contributing) back into the population estimate. Table 3 shows the adjustments made for over-winter losses and Table 4 shows the resulting fall and spring population estimates. The adjusted population estimates do not account for deer illegally killed and removed during the deposition period. The illegal removal is unknown, but perhaps sizable. The actual fall population is, therefore, slightly larger than the reported estimate and the spring population slightly smaller.

SURVEY LOCATIONS

During the spring of 2003, wildlife staff conducted a deer pellet group survey in the western UP and the DMU 452 (Core Area) of the NLP (Figure 1). The western UP was divided into 3 snowfall units. The High Snowfall Unit consists of DMUs 042, 066, and most of 007. The Medium Snowfall Unit consists of DMUs 036, 152, 252, and the remainder of 007. The Low Snowfall Unit consists of DMUs 022, 055, 122, and 155.

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Figure 1

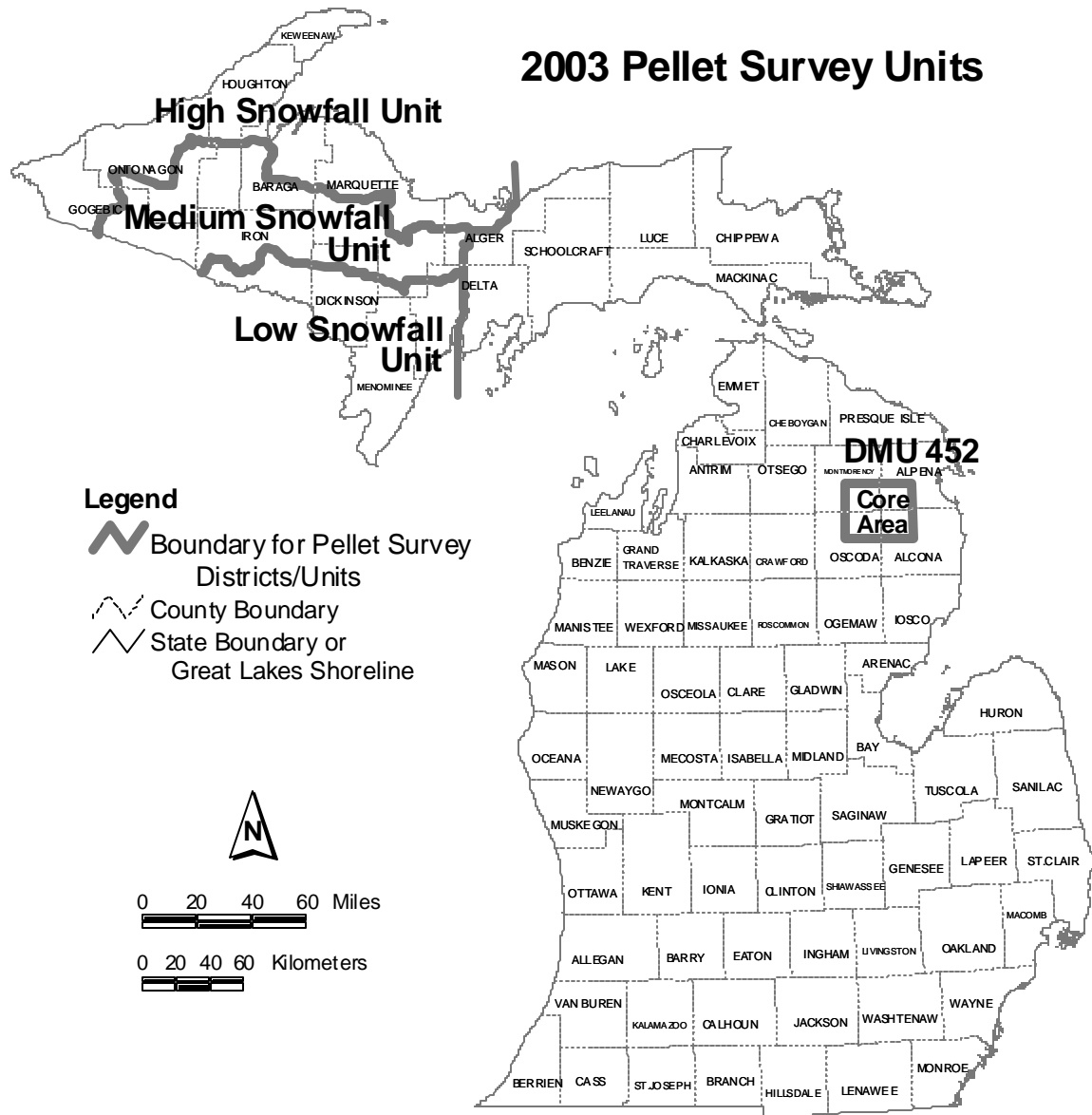


Table 1

NUMBER OF DEER PELLET GROUPS PER COURSE BY STRATUM

<u>Unit</u>	<u>Stratum</u>	<u>Number of Sections</u>	<u>Number of Samples</u>	<u>Average Groups/Course</u>	<u>Standard Deviation</u>
High Snowfall	I	154	9	22.78	16.11
	II	406	9	6.39	4.87
	III	3,691	33	6.67	9.79
Medium Snowfall	I	440	13	18.88	15.60
	II	1,333	33	16.07	17.39
	III	1,917	33	14.36	17.41
Low Snowfall	I	1,385	40	28.18	21.94
	II	1,144	29	20.06	17.53
	III	50	6	31.75	40.01
DMU452 (Core)	I	91	16	20.25	16.06
	II	301	45	15.56	29.23
	III	170	9	6.04	7.48

Table 2

NUMBER OF DEER PELLET GROUPS PER COURSE AND UNADJUSTED POPULATION ESTIMATES BY UNIT

<u>Unit</u>	<u># of Sections</u>	<u># of Samples</u>	<u>Average Grps/Crs</u>	<u>Standard Error</u>	<u>Deposition Period</u>	<u>Deer per Section</u>	<u>Deer in Unit</u>
High Snowfall	4,251	51	7.22	1.50	181	18.96	80,610
Medium Snowfall	3,690	79	15.51	1.98	177	41.65	153,674
Low Snowfall	2,579	75	24.65	2.38	166	70.55	181,951
DMU452 (Core)	562	70	13.44	2.54	162	39.71	22,319

Table 3

ADJUSTMENTS FOR DEER REMOVALS

<u>High Snowfall Unit</u>			
	<u># Removed^a</u>	<u>% Contribution^b</u>	<u>Removal^c</u>
<u>Legal Harvest Mortality</u>			
Archery season	1,823	1.66	30
Firearm season	7,327	6.63	486
Muzzleloader season	668	19.34	129
Late season	166	28.73	48
Total	9,984		
<u>Non-Harvest Mortality</u>			
Fall and early winter losses	7,097	13.81	980
Late winter and spring losses	13,181	63.54	8,375
Total	20,278		
<u>Medium Snowfall Unit</u>			
	<u># Removed^a</u>	<u>% Contribution^b</u>	<u>Removal^c</u>
<u>Legal Harvest Mortality</u>			
Archery season	1,841	2.26	42
Firearm season	8,785	7.34	645
Muzzleloader season	1,015	20.34	206
Late season	39	29.94	12
Total	11,680		
<u>Non-Harvest Mortality</u>			
Fall and early winter losses	5,242	14.69	770
Late winter and spring losses	9,735	65.54	6,380
Total	14,977		

- Estimates of the total number of deer removed during each season during the deposition period. Estimates are from the deer harvest mail survey (legal harvest mortality) and the dead deer survey (non-harvest mortality). Illegally harvest deer removed from the field are not included in the estimates.
- The percent of the deposition period for which the removed deer were present and contributing pellet groups.
- The number of deer removed from the uncorrected over-winter population estimate (adjusted for % contribution) to derive the adjusted spring population estimate.

Table 3 (Continued)

Low Snowfall Unit

	<u># Removed^a</u>	<u>% Contribution^b</u>	<u>Removal^c</u>
<u>Legal Harvest Mortality</u>			
Archery season	2,429	3.01	73
Firearm season	11,619	8.43	980
Muzzleloader season	1,040	22.29	232
Total	15,088		
<u>Non-Harvest Mortality</u>			
Fall and early winter losses	4,738	16.27	771
Late winter and spring losses	8,799	70.48	6,202
Total	13,537		

DMU 452 (Core Area)

	<u># Removed^a</u>	<u>% Contribution^b</u>	<u>Removal^c</u>
<u>Legal Harvest Mortality</u>			
Archery season	629	4.94	31
Firearm season	3,734	10.49	392
Muzzleloader season	110	29.01	32
Late season	109	35.19	38
Total	4,582		
<u>Non-Harvest Mortality</u>			
Fall and early winter losses	404	18.25	75
Late winter and spring losses	173	74.07	128
Total	577		

a, b, c. See page 8.

Table 4

ADJUSTED SPRING AND FALL DEER POPULATION SIZE AND DENSITY (DEER PER
MI²) ESTIMATES BY UNIT AND STRATUM

<u>Unit</u>	<u>Stratum</u>	<u>Fall 2002 Population^a</u>	<u>Fall 2002 Density^a</u>	<u>Spring 2003 Population^b</u>	<u>Spring 2003 Density^b</u>
High Snowfall		100,824	23.72	70,562	16.60
	I		74.79		52.34
	II		20.98		14.68
	III		21.89		15.32
Medium Snowfall		172,276	46.69	145,619	39.46
	I		56.83		48.04
	II		48.35		40.87
	III		43.20		36.52
Low Snowfall		202,319	78.45	173,694	67.35
	I		89.68		76.99
	II		63.86		54.82
	III		101.05		86.75
DMU 452 (Core)		26,782	47.66	21,623	38.48
	I		71.80		57.97
	II		55.18		44.55
	III		21.41		17.28

- a. Fall population measures are calculated from the spring population measures presented here plus the total number of deer removed from the population over the winter presented in Table 3.
- b. Spring population measures are calculated from the unadjusted population measure presented in Table 4 minus the adjusted (for % contribution) number of deer removed presented in Table 3.